Hall Ticket No | | | | | | | | | | | Question Paper Code: AAEC16

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal-500043, Hyderabad

B.Tech V SEMESTER END EXAMINATIONS (REGULAR/ SUPPLEMENTARY) - FEBRUARY 2024
Regulation: UG20
HIGH SPEED AERODYNAMICS
Time: 3 Hours **(AERONAUTICAL ENGINEERING)** **Max Marks: 70**

Answer ALL questions in Module I and II
Answer ONE out of two questions in Modules III, IV and V
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) Illustrate different regimes of compressible flow by considering an aerodynamic body in a flowing gas. [BL: Understand| CO: 1|Marks: 7]

   (b) An aircraft is flying at a speed of 1000 kmph. Compute the variations in speed of sound a, and Mach number M with altitude change from sea level and at 11 Km. [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) Explain the formation of oblique shock wave in a concave corner and expansion fan in convex corner. [BL: Understand| CO: 2|Marks: 7]

   (b) For a Prandtl - Meyer expansion, the upstream Mach number is 2 and the pressure ratio across the fan is 0.5. Determine the angles of the front and end Mach lines for the expansion fan relative to the free stream. [BL: Apply| CO: 2|Marks: 7]

MODULE – III

3. (a) Determine the equation of a Fanno curve. Prove that at the maximum entropy point Mach number is unity. [BL: Understand| CO: 3|Marks: 7]

   (b) Air enters, a long circular duct of diameter 12.5 cm and mean coefficient of friction 0.0045, at a Mach number of 0.5, pressure 3 bar and temperature 312 K. If the flow is adiabatic throughout the duct, determine

   i) The length of the pipe required to change the Mach number to 0.7

   ii) Pressure and temperature of air at M=0.7

   iii) The length of the pipe required to attain limiting Mach number

   iv) Pressure, temperature and Mach number at the limiting condition

   [BL: Apply| CO: 3|Marks: 7]

4. (a) Develop an expression for area ratio in terms of Mach number for isentropic flow. [BL: Understand| CO: 4|Marks: 7]

(b) An air nozzle is to be designed for an exit Mach number of 2.5. Conditions of the air available in the reservoir are 800 kPa, 523 K. Estimate

i) Pressure

ii) Temperature

iii) Velocity of flow

iv) Area, at throat and exit of the nozzle. Mass flow rate through the nozzle is 12000 kg/hr

[BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Outline about supercritical airfoil. Explain how the critical Mach number is increased?

[BL: Understand| CO: 5|Marks: 7]

(b) Using linearized theory, calculate the lift and drag coefficients for a flat plate at a 5^0 angle of attack in a Mach 3 flow. [BL: Apply| CO: 5|Marks: 7].

6. (a) Determine the expression for area-velocity relation of a convergent-divergent duct.

[BL: Understand| CO: 5|Marks: 7]

(b) For certain aerofoil at given point on the upper surface of the aerofoil, the pressure coefficient is -0.27 at very low speed. If the free stream Mach number is 0.75, calculate C_p and C_m at this point. [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) What do you understand by expansion tube? Explain with suitable diagram.

[BL: Understand| CO: 6|Marks: 7]

(b) Discuss in detail about the working of supersonic wind tunnels with suitable sketch.

[BL: Understand| CO: 6|Marks: 7]

8. (a) Mention the advantages and limitations of using fluorescent particles for flow visualization in compressible flows. How does this technique contribute to understanding flow patterns and characteristics? [BL: Understand| CO: 6|Marks: 7]

(b) Illustrate the working of a shock tunnel with suitable diagrams and explain the function of each component. [BL: Understand| CO: 6|Marks: 7]

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